D R A F T
NPIC/P&DS.D.6- 1663
31 October 1966

MEMORANDUM FOR: Chief, Procurement Division, OL

THROUGH: Chief, Support Staff, NPIC

X1 ATTENTION: [redacted] Contracts Branch

SUBJECT: Contract [redacted] 25X

X1 [redacted]

1. The attached letter from [redacted] requests a 25X time extension for completion of the subject contract. This extension will provide for experiment completion which will result in a more comprehensive final report.

2. It is therefore requested that the contract be amended to extend the completion date to 30 November 1966 at no increase in cost.

[redacted] 25X

Colonel, USAF
Assistant for Plans and Development, NPIC

Attachment:
Contractor's Letter
dated 19 October 1966

Distribution:
Original and 1 - Addressee
1 - CH/SS/NPIC
1 - CH/PD/OL
3 - P&DS/DB

X1 NPIC/P&DS [redacted] (31 October 1966)

Memorandum for: Chief, Procurement Division/OL

Through : Chief, Support Staff, NPIC

25X1 Attention : [redacted] Contracts Branch 25X1

Subject : [redacted]

25X1

1. The attached letter from [redacted] requests a time extension for completion of the subject contract. ~~It is felt the approval of~~ This extension will provide ~~time~~ for experiment completion which will result in a more comprehensive final report.

2. It is therefore requested that the contract be amended to extend the completion date to 30 November 1966 at no increase in cost.

[redacted] 25X1

Atch: Contractor's Letter,
dated 19 October 1966

first sentence —

~~for~~

most of the past effort was based on the tech objectives which included aquisition speed requirements, this prevented the attainment of meaningful data pending resolving the speed question.

~~[redacted]~~

2 The question of BZW has not been seriously engaged. I am satisfied it can be acquieved with some room in bleached array. The stated achievable density of ~~[redacted]~~ 2 is realy more than is required for natural viewing.

3. NO step tablet shots have been made - but from comparisons I have made I am confident of 14 steps

4. Requires more effort to attain data

5 Two approaches not discussed (1) stripping film containing cat-. 2 Limited sensitivity to white light.

Approved For Release 2005/06/06 : CIA-RDP78B04770A002800040020-7

Will J.

This is the info that Max promised.

Barbara

19 Aug 1966

THE PHOTOBLEACH PHOTOGRAPHY PROCESS

Photobleach photography is a dry direct-positive printout process for reproducing transparencies. A photobleach material consists of an opaque photosensitive film, cast on a transparent support such as Mylar film or glass, or on paper. A film consists of a solution of dyes and photosensitive agents (PSA) in a suitable polymer. Exposure to light causes a reaction in the film which bleaches the dyes. The film is rendered insensitive to light by heating, thus fixing the image formed during the exposure.

Color and Density. As a design goal, the unexposed film should appear black by visual inspection and be bleached by exposure to a white or neutral gray. No individual black dyes examined thus far possess these properties so a visual black is being approximated by a combination of red, blue and yellow dyes. A careful balance of dyes is necessary to achieve black and neutral grays.

The final selection of dyes and optimum concentrations has not been made and experiments are still being conducted in this area. The major difficulty in dye selection and balance is the achievement of neutral gray bleached zones. Some individual dyes, notably red ones, have been bleached to clear end products. Opaque black can be approximated by several formulations, but the bleached areas appear a light brown or tan color.

The optical density of a film is directly proportional to the dye concentration. For a film containing a single dye, the optical density is, of course, highly variable with wavelength, showing a maximum at one or two wavelengths and decreasing to very low values at other wavelengths. For dye mixtures, the absorptions overlap, and the density becomes more uniform. Even for a film that looks black to the eye, however, the density is not completely uniform across the spectrum.

Similarly, the optical density of the bleached film depends on the concentration and the absorption spectrum of the products of the photoreaction. When a dye reacts with a photosensitive agent, new compounds are formed, both from the dye and from the photosensitive agent. These products have their own absorption spectra, and are responsible for the colors of the bleached area. Absorption spectra of some frequently used dye-PSA combinations, singly and in mixtures, are shown in Figures 1 to 3. Films derived from mixtures similar to that in Figure 3 have been made with an average optical density of 2 which have been bleached to an average optical density of 0.3.

Latitude. A response latitude of fourteen steps of a standard gray scale has been demonstrated on representative materials. The latitude of the final materials is expected to be slightly higher.

Sensitivity. The photographic speed of photobleach materials varies over several orders of magnitude, depending on the dye-PSA combination. Using a 300 watt projector as an exposure source, adequate exposures can be achieved in periods ranging from a few seconds to several minutes, depending on the materials used. Figures 1 to 3 illustrate the variation of sensitivity with dye. In each figure, each curve is labeled with the time of exposure in a 300 watt projector.

Sensitivity varies with the wavelength of the light used for exposure. For some dyes, such as Rose Bengal, light absorbed by the dye itself can cause bleaching. For such dyes the sensitivity follows the absorption spectrum quite closely. For other dyes, such as Indophenol Blue, light absorbed by the dye is not effective, and only light absorbed by the photosensitive agent causes bleaching. In all cases, light absorbed by the photosensitive agent is more effective than light absorbed by the dye. The photosensitive agents absorb in the near ultraviolet, where the intensity of a tungsten light source is low. A mercury arc source with its greater output in the ultraviolet leads to a shorter exposure time than a tungsten source of comparable average intensity.

Fixing. The film is desensitized by heating the exposed film in an oven for a predetermined time, whereupon photosensitive agent evaporates or decomposes. No development step is needed in the photobleach process, although the extent of bleaching of some materials is enhanced by the heating process. At present, reliable fixing is obtained by heating at about 110°C for two hours. The usual test for satisfactory fixing is exposure in the 300 watt projector for ten minutes, after which examination should reveal no additional bleaching.

The time of fixing can be decreased by raising the temperature. This, however, leads to several problems which are still under investigation. These include thermal reactions between dye and PSA, loss of resolution due to film flow, and distortion of Mylar substrates. Each of these problems is amenable to proper selection of materials, and their investigation is planned for the next phase of the work. In addition, investigation of a technique for the avoidance of the necessity of fixing by the use of materials sensitive only to ultraviolet is also planned.

Resolution. The photobleach reaction takes place on a molecular basis: one molecule of dye reacts with one molecule of PSA when activated by one photon to produce a small number of molecules of reaction products. Therefore, the ultimate resolution capability due to the material itself should be of the order of a molecular diameter, or about 10^{-5} mm. The theoretical resolution limit in the visible region due to the nature of light is about 1000 line pairs/mm. Diffusion, and the heat fixing step may also affect the resolution. A resolution of 350 line pairs/mm has been demonstrated on a heat fixed sample.

Reciprocity Characteristics. The reciprocity law has been briefly tested for a few systems. The tests consisted of the interposition of calibrated neutral density filters up to a density of 1.0 between the exposure source and the PBP materials. In all cases, the results were those predicted from the reciprocity relationship, within the reproducibility of the materials.

Characteristic Curve and Contrast

A plot of optical density against time is shown in Figure 4. This curve, reproduced from a previous report, is typical of the curves generated by photobleach materials. Figure 4 is the curve for a mixture of three dyes which bleached from black to tan. The slope of the straight portion of the curve is 0.8. The corresponding slope for other photobleach materials is usually between 0.8 and 1.1, although higher values have occasionally been noted. The slope of the curve for a given sample may be changed by heating the sample during exposure. The utility of this technique for varying contrast at will is to be investigated in the future.

Summary

Photobleach photography provides a direct positive, dry process for reproducing transparencies. At the present state of development, it has the following properties:

1. A black film of optical density 2 can be bleached to a tan of optical density 0.3.

2. This film shows a latitude of fourteen steps.

3. The exposure required to achieve the first result is one minute and the second is six minutes in a 300 watt projector. A mercury source decreases this time considerably.

4. Resolution of 350 lines/mm has been demonstrated.

5. The film can be fixed by heating for two hours at 110°C with no loss of resolution.

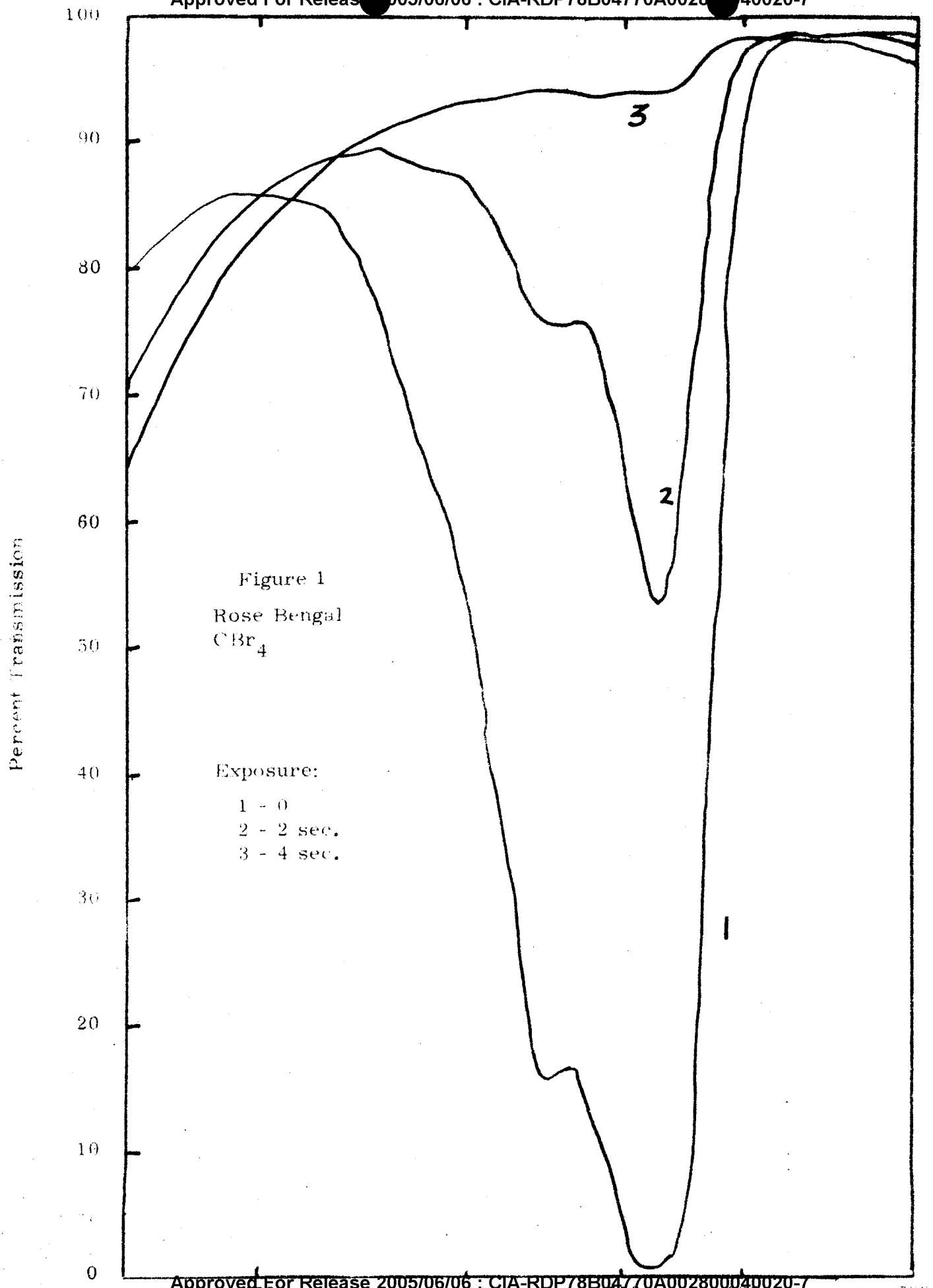


Figure 1

Rose Bengal
CBr_4

Exposure:

1 - 0
2 - 2 sec.
3 - 4 sec.

Figure 2

Indophenol Blue-CH_3

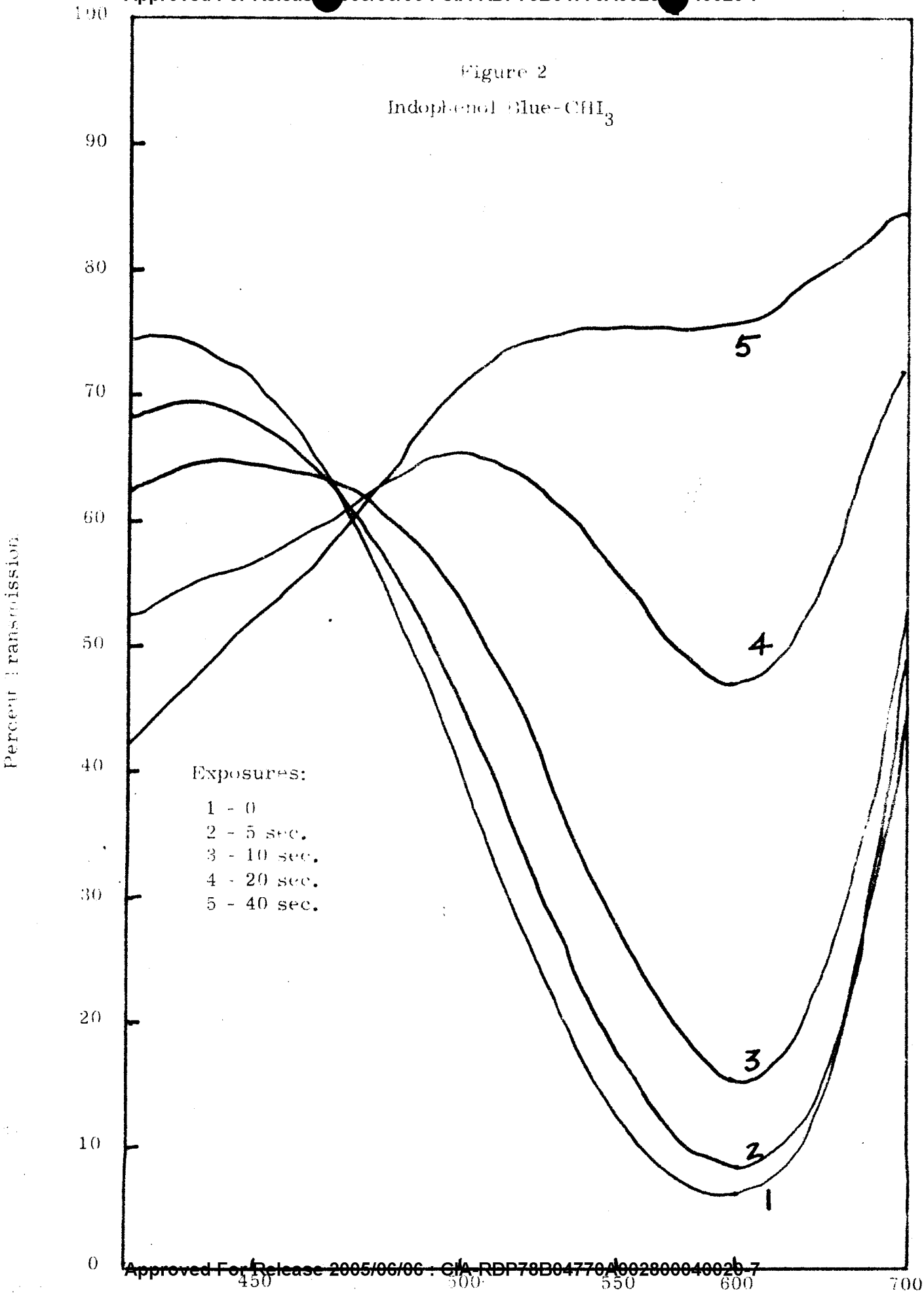
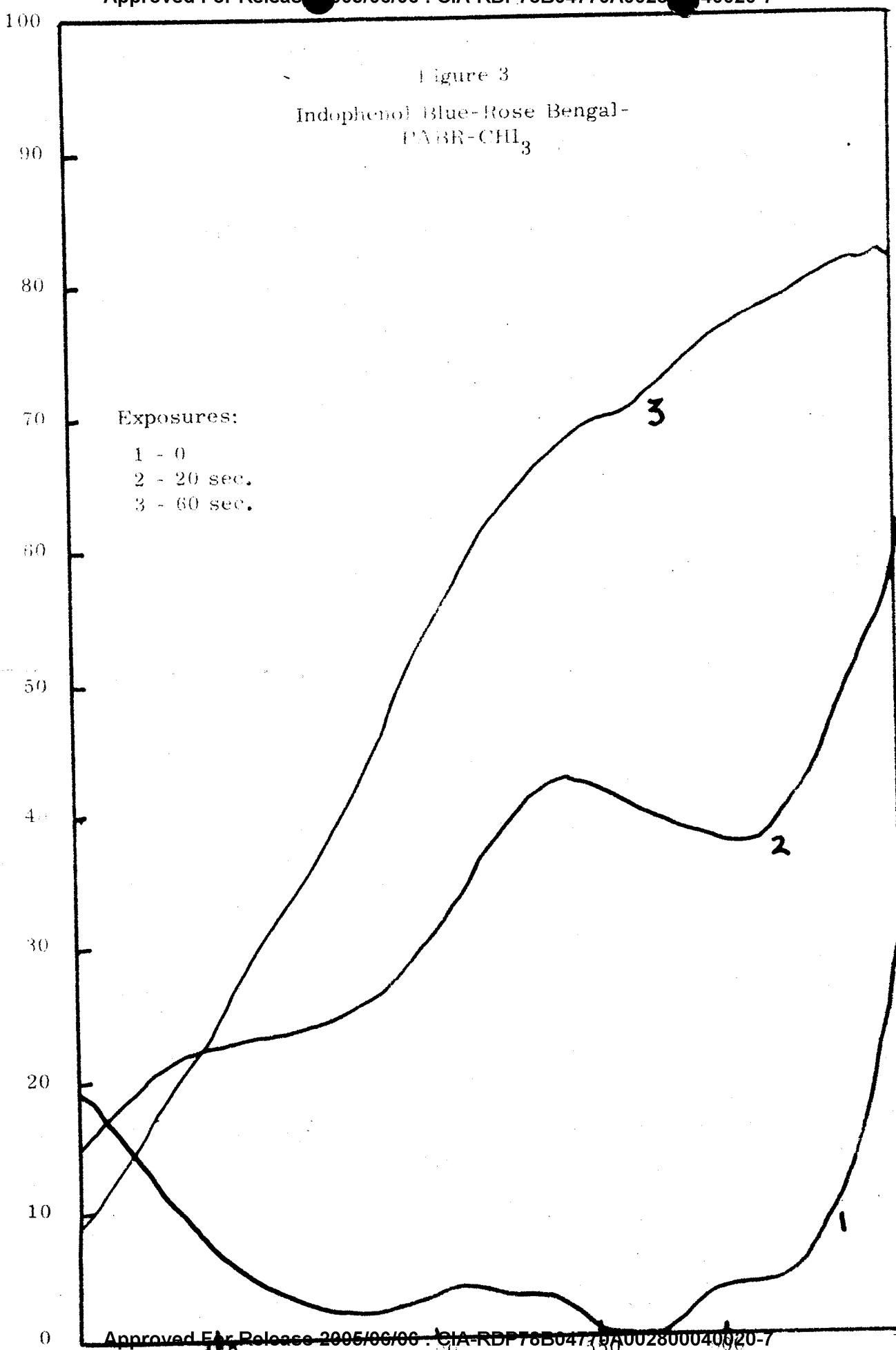
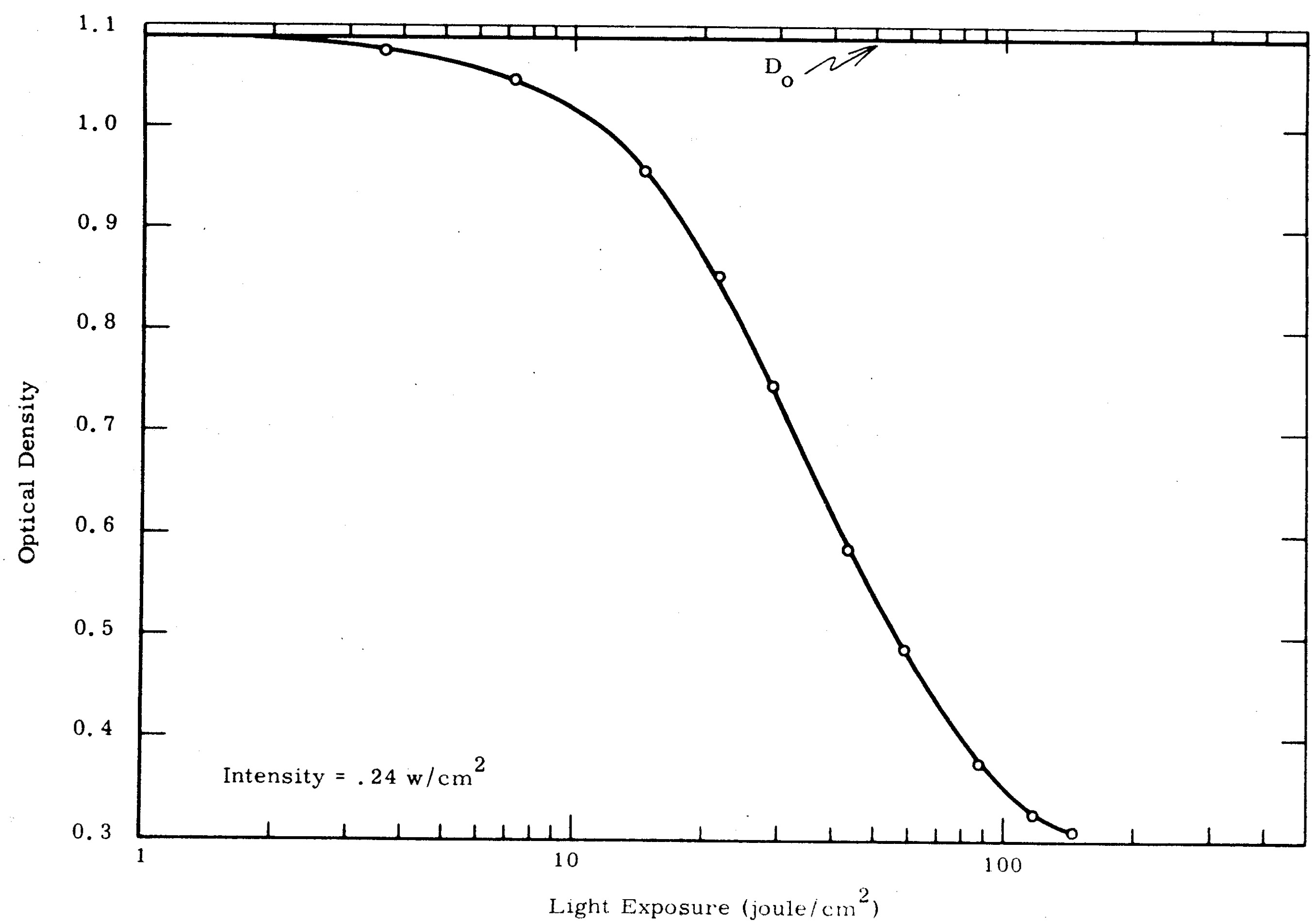


Figure 3

Indophenol Blue-Rose Bengal-
PVBR-CHI_3




1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Optical Density
D
o
Intensity = .24 w/cm2
1
10
100
Light Exposure (joule/cm2)

Subject: Photobleach Photography Study

Classification: Conf. Project No. 10017

Originator: [redacted] Date: 25 July 66

	Initials	Date
(1) Unit Leader	[signature]	25 July
(2) Type Rough	✓	✓
(3) Section Chief		
(4) Chief, DB		
(5) Asst. for P&DS		
(6) Originator		
(7) Type Smooth		
(8) Section Chief		
(9) Chief, DB		
(10) Asst. for P&DS		

Date of Final Disposition:

File Copy:

(1) Deputy Chief, DB		
(2) Originator		
(3) Section Chief		
(4) Secretary (For Filing)		

REMARKS:

PHOTOBLEACH PHOTOGRAPHY STUDY

1. PROBLEM.

To provide NPIC with the capability for positive to positive, rapid, dry reproduction of selected areas of photographic imagery.

2. FACTS BEARING ON THE PROBLEM.

a. There is no satisfactory dry method for rapidly and selectively reproducing positive to positive photographic imagery without a major loss of information content. The present method of physically cutting desired areas out of the second generation dupe positive film is both costly and time consuming.

b. Existing dry processes which fulfill the positive to positive requirement are limited, the Diazo process being the only acceptable process. However, the Diazo process generates a most undesirable ammonia vapor environment. The Kalvar dry process is a non-reversal system which produces a positive product from a negative input. The current investigation of a [redacted] 25X1 [redacted] dry process will also yield a non-reversal positive to negative material.

c. The normal wet chemical silver photographic reproduction systems, although fulfilling the requirement of the output material, are time consuming, require a considerable amount of processing equipment and a darkroom environment.

d. Applied research on the photobleach process as carried on by the [redacted] X1 during the past two years shows excellent possibilities of meeting the requirements of speed, gray scale, resolution and ease of handling. The existing problems, which are associated with gamma control and rapid fixing, will be the major

areas of emphasis in the proposed investigation.

e. This project will be a one-year effort--a follow-on to a two-year

X1 contract with [redacted]

3. DISCUSSION.

a. Current Procedures - The current reproduction processes in use are the typical wet photographic laboratory techniques which requires a variety of equipments, trained photo lab technicians for operation of the equipment, and time consuming methods.

b. Origin of Concept - The need for high quality cut film or film chips for interpretation has been established by the fact that second generation roll film duplicates are furnished to the operational components of NPIC for analysis. A minimum number of these rolls are available for analysis, therefore, the photo analyst physically cuts his areas of interest from the roll, and passes the remainder to an analyst performing in a different subject area. Additionally, the cut film pieces are much easier to handle, file and retrieve than the roll film.

c. Proposed Project - This effort is expected to provide the means to enable an interpreter, untrained in photo lab procedures, to make positive to positive duplicates with controlled gamma and density, at a light table in a matter of a few minutes. It requires further investigation of a completely dry, light sensitive, photographic material utilizing heat to process and fix. It is the intent of this effort to meet or surpass those requirements established during the FY-1966 program and which are contained in detail in the Technical Specifications (TAB-B).

d. Selection of Contractor - This project is based on an unsolicited

X1 proposal from [redacted] for a follow-on effort to an existing contract. Investigation of current methods and techniques have shown that no equally promising techniques are available.

e. Program Phasing - The proposed effort for FY-1967 is a follow-on to two previous phases of investigatinn funded during FY-1965 and FY-1966. The present contract (Phase II) will be completed in August 1966. It is anticipated that the FY-1967 program will logically follow those investigative areas already under study and will result in experimental materials and breadboard equipment. The goals to be attained and estimated milestones are shown in TAB-D.

f. Coordination - This project was fully coordinated throughout the intelligence community at the outset in FY-1965. A review of recent advances, both in industry and DOD, indicates that the requirement has not been met and that this study is not a duplication of other efforts.

g. Alternatives - The FY-1965-1966 program phase was funded in the amount [redacted] and covered the first two investigative phases of the program. The proposed FY-1967 funding in the amount of [redacted] is felt to be in line with the type of investigation being carried on. Funding the effort at a lower figure would mean a cut-back in all areas of endeavour and would probably result in an incomplete investigation and inconclusive results. The process, as being investigated [redacted] is proprietary to that company, therefore no other contractor was solicited to perform this investigation.

X1 25X 25X

4. CONCLUSIONS.

This investigative effort was started [redacted] in August 1964. Through two years effort, feasibility of the process has been shown and documented through reports and sample materials. Many major objectives have been achieved. This proposed effort will accomplish the remaining objectives which are: control of contrast, shortening of fixing time, and the formulation of a single photographic medium. There is every reason to believe that these objectives will be met and that a single, practical film

25X

for positive to positive, dry reproduction will be successfully developed.

5. RECOMMENDATIONS.

X1 It is recommended that the [redacted] proposal be accepted for an additional twelve months research and development effort in the area of photo-bleach photography and that a cost plus fixed fee contract be negotiated

[redacted] 25X

6. REFERENCES AND ATTACHMENTS.

TAB A - R&D Catalog Form

TAB B - Technical Specifications

TAB C - Detailed Objectives

TAB D - Program Phasing

X1 Attachment - [redacted] Technical Proposal